

1. A method of monitoring a rotating synchronous electric machine (9), which comprises a rotor having a rotor winding and a stator having a stator winding, the method comprising the steps of

determining the stator winding current,  
determining the stator winding voltage,  
determining the rotor winding current, and

estimating the temperature in at least two positions in the electric machine (9) using a theoretical model of the electric machine and the determined current and voltage values.

2. A method as claimed in claim 1, which method further comprises the step of measuring the temperature in at least one point in the machine and wherein the temperature estimates are effected also in dependence on the measured temperature.

3. A method as claimed in claim 1 or 2, which further comprises the step of measuring the rotor speed and wherein the temperature estimates are effected also in dependence on the measured rotor speed.

4. A method as claimed in claim 1, 2 or 3, wherein the electric machine is cooled by at least one coolant, wherein the temperature of the coolant is measured and wherein the temperature estimates are effected also in dependence on the measured temperature of the coolant.

5. A method according to any one of the preceding claims, wherein the rotor according to the model is divided into zones in the axial direction of the machine and wherein the temperature is estimated for each zone.

6. A method according to any one of the preceding claims, wherein the rotor according to the model is

REPLACED BY  
ART 34 AMDT

divided into zones in the radial direction of the machine and wherein the temperature is estimated for each zone.

7. A method according to any one of the preceding claims, wherein the stator according to the model is divided into zones in the axial direction of the machine and wherein the temperature is estimated for each zone.

8. A method according to any one of the preceding claims, wherein the stator according to the model is divided into zones in the radial direction of the machine and wherein the temperature is estimated for each zone.

9. A method of controlling at least one variable in a rotating synchronous electric machine (9), which comprises a rotor having a rotor winding and a stator having a stator winding, the method comprising the steps of

determining the stator winding current,  
determining the stator winding voltage,  
determining the rotor winding current, and

estimating the temperature in at least two positions in the electric machine (9) using a theoretical model of the electric machine and in dependence on the determined current and voltage values, and

controlling said at least one variable in dependence on the estimated temperatures and using the model of the electric machine.

10. A method as claimed in claim 9, wherein controlling said at least one variable comprises controlling in such manner that at least one of the estimated temperatures is kept essentially constant.

11. A method as claimed in claim 9 or 10, which method further comprises the step of measuring the temperature in at least one point in the stator and wherein the control of said at least one variable is effected also in dependence on the measured temperature.

12. A method as claimed in any one of claims 9-11, wherein the electric machine is cooled by at least one coolant, wherein the temperature of the coolant is measured and wherein the control of said at least one variable is effected also in dependence on the measured temperature of the coolant.

13. A method as claimed in any one of claims 9-12, which further comprises the step of measuring the rotor speed and wherein the control of said at least one variable is effected also in dependence on the measured rotor speed.

14. A method as claimed in any one of claims 9-13, which further comprises the step of measuring the temperature of the medium surrounding the electric machine and wherein the control of said at least one variable is effected also in dependence on the measured ambient temperature.

15. A method as claimed in any one of claims 9-14, wherein controlling said at least one variable comprises controlling the current supplied to the rotor.

16. A method as claimed in any one of claims 9-15, wherein controlling said at least one variable comprises controlling the supplied cooling effect.

17. A method as claimed in any one of claims 9-16, wherein the electric machine is a generator and wherein controlling said at least one variable comprises controlling the supplied power.

18. A method as claimed in any one of claims 9-16, wherein the electric machine is an electric motor and wherein controlling the electric motor comprises controlling the load.

19. A method as claimed in any one of claims 9-18, wherein control is effected by means of a first allowable

REPLACED BY  
ART 34 AMDT

33

temperature and a second allowable temperature, wherein control is effected in such manner that said estimated temperatures are allowed to reach the first allowable temperature as a steady value and that said estimated temperatures are allowed to reach the second allowable temperature only for a predetermined period of time.

20. A method according to any one of claims 9-19, wherein the rotor according to the model is divided into zones in the axial direction of the machine and wherein the temperature is estimated for each zone.

21. A method according to any one of claims 9-20, wherein the rotor according to the model is divided into zones in the radial direction of the machine and wherein the temperature is estimated for each zone.

22. A method according to any one of claims 9-21, wherein the stator according to the model is divided into zones in the axial direction of the machine and wherein the temperature is estimated for each zone.

23. A method according to any one of claims 9-22, wherein the stator according to the model is divided into zones in the radial direction of the machine and wherein the temperature is estimated for each zone.

24. A method according to any one of claims 9-23, wherein the temperature of at least one of the bus-duct (IPB), the generator circuit breaker (GCB) and the generator step-up transformer (GSU) is measured and used to control the generator output.

25. A method according to any one of claims 9-24, wherein the temperature of at least one of the bus-duct (IPB), the generator circuit breaker (GCB) and the generator step-up transformer (GSU) is measured and used to control the cooling power for at least one of the bus-

REPLACED BY  
ART 34 AMDT

34

duct (IPB), the generator circuit breaker (GCB) and the generator step-up transformer (GSU).

26. A control apparatus for controlling a rotating synchronous electric machine, characterized in that it comprises at least stator current and stator voltage signal inputs, and that the control apparatus is arranged to transmit control signals for controlling at least one variable in the electric machine in dependence on the signals on the signal inputs and using a model of the electric machine, which model is used to estimate the temperature in at least two positions in the electric machine.

27. An apparatus for monitoring a rotating synchronous electric machine, characterized in that it comprises at least stator current and stator voltage signal inputs, and that the control apparatus is adapted to estimate the temperature in at least two positions in the electric machine in dependence on the signals on the signal inputs and using a model of the electric machine.

28. An apparatus as claimed in claim 27, which further comprises a storage means, the estimated temperatures being stored in the storage means.

29. An apparatus as claimed in claim 27, which further comprises a display means on which the estimated temperatures are displayed.

30. A power plant for generating electric power, comprising a turbine and a generator connected thereto, and a control apparatus as claimed in claim 26.

31. A synchronous compensator for synchronous compensation, which is controlled by means of a control apparatus as claimed in claim 26.

32. Use of a method as claimed in any one of claims 1-25 in a power plant for generating electric power,

REPLACED BY  
ART 34 AMDT

35

which power plant comprises a turbine and a generator connected thereto.

33. Use of a method as claimed in any one of claims 9-25 for controlling an electric synchronous motor.

34. A memory medium on which a computer program is stored for controlling a rotating synchronous electric machine, which comprises a rotor having a rotor winding and a stator having a stator winding, characterized in that the computer program when executed on a computer causes the computer to

receive an input signal containing stator winding current data,

receive an input signal containing stator winding voltage data, and

estimate the temperature in at least two positions in the electric machine using a theoretical model of the electric machine.

35. A memory medium as claimed in claim 34, which is further adapted to transmit an output signal for controlling the electric machine in dependence on the estimated temperatures.